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NATO Technology: from Gap to Divergence?

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Overview

A widening technology gap between the United States and other NATO members will challenge the ability of NATO to function as a cohesive, multinational force. Over several decades, great disparities in the funding of defense research and technology by NATO members has produced a widening technological gap that threatens to become a divergence—a condition from which the Alliance may not be able to recover. The technology gap, in turn, is creating a capabilities gap that undercuts the operational effectiveness of NATO forces, including the new NATO Response Force.

With only slight modifications (not additions) to current total defense expenditures, and using funds that will be available as they restructure their forces, European members could not only double their current investment but take significant strides to ensure that they are not left behind in a world dominated by technology.

In addition, and of equal importance, the United States must share more of its fundamental basic and applied research with NATO partners, take a greater role of leadership in NATO's Research and Technology Organization(RTO), and increase participation across all technical areas in the RTO. These primary actions, coupled with other actions by all NATO nations and the Allied Command Transformation, offer the potential to dramatically improve a situation that very much needs immediate attention. It is a relatively straightforward matter now. NATO has both a capabilities gap and a technology gap. Immediate attention to the latter, with a commitment by every NATO nation to invest three percent of its military budget in research and technology, may, over time, significantly reduce the capability gap.

One of the major results of the Prague Summit in November 2002 was the formal recognition of the military capabilities gap between the United States and the other NATO nations. Members made a strong commitment to address this gap, especially in strategic transport, UAVs, precision guided munitions, air-to-air refueling, maritime counter-mine capabilities, and nuclear, chemical, and biological identification and defense capabilities. The Prague Capabilities Commitment is silent on a major long-term issue—funding of the defense research and technology needed to reduce the capabilities gap over the long term.

The United States makes the largest annual investment in warfighting capability in the world, exceeding that of the closest NATO members by an order of magnitude.[1] The disparity is even greater when one compares how the NATO nations invest their budgets. The United States spends approximately 35 percent of its defense budget on personnel, 30 percent on equipment expenditures, and the remainder in miscellaneous areas, including infrastructure.[2] By comparison, Belgium and Italy spend over 70 percent on personnel. France, Germany, Greece, Italy, Poland, and Spain each spend approximately 60 percent on personnel. These same nations make investments in equipment that range from 5 percent (Belgium) to 20 percent (France), with most countries investing around10 percent.[3] These imbalances have existed for years.

The effect of this mismatch on defense investments is considerable: an overly large force structure in much of NATO that is ill equipped (as well as ill trained) to fight modern conflicts, and a widening technology gap between the United States and the rest of NATO.

In recent years, the United States has undergone its most significant military transformation since World War II as it has aligned and equipped itself to meet changing threats. The resulting forces are lighter, more mobile, and more lethal than ever before. The

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United States has transformed so rapidly that it has left its traditional allies behind.

Consider air power. The capabilities gap here is unquestionably one of the largest. The United States has the only significant strategic transport, refueling, surveillance, and bomber capabilities among the NATO nations—at a time when the Alliance has committed itself to out-of-area activities. This mismatch in capabilities may be stemmed slightly by the Prague Capabilities Commitment.

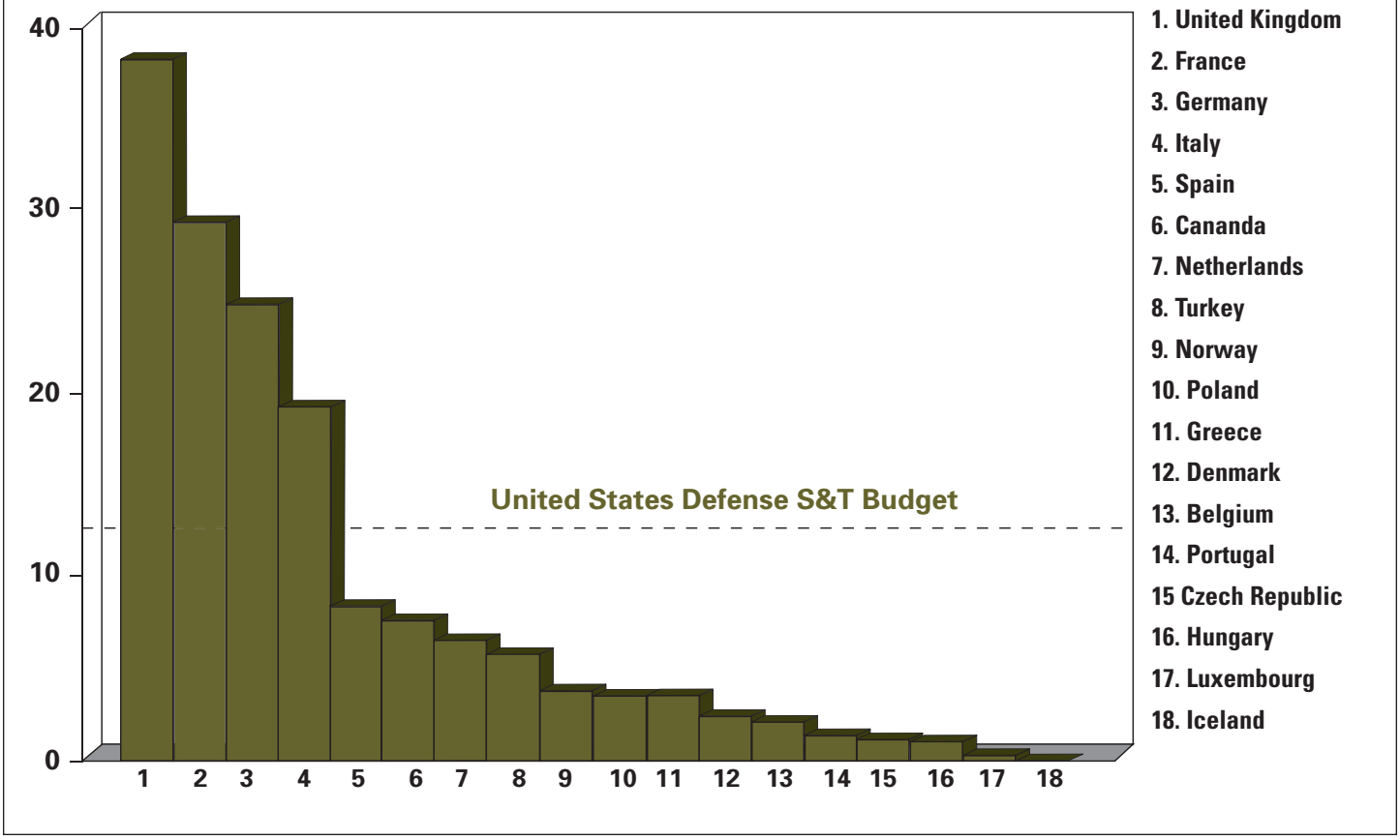
The air power gap widens when one considers the fighter and attack aircraft, such as the F/A-22 and F-35, that the United States will introduce this decade.[4] These aircraft will feature such new capabilities as all-internal carriage of air-to-air and air-to-ground weapons, materials and vehicle shaping to provide low observable characteristics, supersonic cruise without afterburner, and vertical/short take off and landing. Unmanned combat air vehicles contribute additional capabilities unmatched by other NATO members. The X-45A, for example, which is now undergoing testing in the United States, with a possible initial operational capability around 2010, features all-internal carriage of weapons and low observable characteristics.

The widening NATO capabilities gap is driven by many elements, the most important of which is defense funding. A subset of the capabilities gap is driven by the dominant role of technology in nearly every facet of modern society. Again, funding plays a key role.

Research and Technology Investments

The United States invests over $12 billion annually in defense science and technology (S&T). This includes approximately $1.5 billion in basic research, $4.5 billion in applied research, and $6 billion in advanced technology development. To put the magnitude of this investment in perspective, the U.S. defense S&T program exceeds the total annual defense investments of its NATO allies Belgium, Canada, the Czech Republic, Denmark, Greece, Hungary, Luxemburg, the Netherlands, Norway, Poland, Portugal, Spain, and Turkey.

Defense Budgets of European Members Compared to U.S. Defense S&T Budget



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(See chart.) Only the United Kingdom, France, Germany, and Italy invest more in their total defense programs than the United States does in defense research and technology alone. The total defense research and technology annual investment by all other NATO nations combined is estimated to be only $3 billion.

The American investment in defense research and technology has increased dramatically during the Bush administration, which considers this investment to be a major factor in enhancing the quality of U.S. armed forces, with almost all of this increase going to advanced technology development. The significance of this increase should not be lost on NATO, as it will yield even more advanced technology for the U.S. armed forces in the near term.

In addition to the near-term investments already mentioned (again using air power examples), the United States is the only nation in the world investing significantly in longer-term technologies, such as hypersonics, a technology featured in the Defense Department's National Aerospace Initiative. This initiative features, among other things, research in hypersonic scramjet propulsion with potential application to air-to-ground missiles, long-range strike aircraft, and two-stage-to-orbit space vehicles with an airbreathing first stage. None of these capabilities, the latter two of which are revolutionary, are even on the long-term planning horizon of any other NATO nation.

Unfortunately, additional potentially revolutionary technology areas can be cited in which the United States is making significant investments and NATO colleagues are doing at best very little. These areas include directed energy laser and high-power microwave devices, distributed mission training, miniaturized conventional weapons technologies, and microsatellites.

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Will the Gap Become Divergent?

The order-of-magnitude differences in defense funding between the United States and other NATO members, if sustained, eventually will cause such a wide gap in technical capabilities that a divergence will occur. The great danger here is that, whereas a gap can be narrowed over time by sufficient investment, a divergence may be unrecoverable. Should this divergence occur, the Alliance is at risk.

Given that, at least in the short term, the United States is unlikely to reduce military spending, NATO and, more important, the NATO nations, must make this issue a very high priority. The time to address the issue is now, and the amount of time to resolve it is perhaps a decade. Ten years from now, the United States may have so many revolutionary technologies that it is difficult to imagine how NATO units so mismatched in technical capability will be able to function as a cohesive, allied force.

Other factors also must be considered. Fortunately, technology matures slowly from basic research to completion of advanced technology development, and it may be that time is on NATO's side. Another factor to consider is that technologies that offer significant promise today may not pan out. Research and technology development are risky undertakings; spending vast resources does not guarantee success in solving difficult technical problems. And we sometimes see breakthroughs result from limited funding. This latter point is especially significant for NATO nations that have notable research and technology establishments and personnel who stay well connected to worldwide research projects and the results these projects are producing.

The Way Ahead

Specific actions taken now by NATO and member nations could have a dramatic, positive effect on the Alliance. Although many technology areas are important to the Alliance, certain areas, including the personnel and infrastructure to support them, are more important in today's military environment; these areas also are discussed. The Alliance is fortunate to have at this time a major Command that is charged with transformation and recognizes the need for aggressively transitioning technology to the operational forces.

Funding

No discussion of the way ahead for reducing NATO capabilities and technology gaps can avoid funding, and there is, perhaps, a glimmer of hope for the future. The good news comes from the fact that small, but consistently sustained, investments in research and technology could make a significant difference in the technology gap. Even for a defense program as large as that of the United States, research and technology investment is only about 3 percent of the total defense budget. If all NATO nations would invest this same percentage amount in defense research and technology programs, we could see an effective doubling of the investment by the non-U.S. nations. This singular investment in the future, requiring no new funds, but rather a reprioritization, would set the stage for the Alliance to maintain essential technical connectivity across all nations. It can be achieved if members sustain their defense funding at current levels and make the funding of research and technology a top priority using funds made available by reduction of force components.

The European members of NATO also could benefit by closer cooperation and collaboration among themselves in defense research and technology investments. There is a sense in some quarters that significant, unnecessary duplication persists among member nations. This negative effect is further compounded by problems with interoperability as technologies enter development phases.

The United States

NATO is fortunate to have a strong organization that is specifically chartered to share defense research and technology information.[5] It is imperative, however, that the United States take a stronger leadership position throughout the RTO than it is currently doing. For example, of the seven major technical panels in the RTO, the United States chairs only one, the panel on Information Systems Technology.[6] These panels form the heart of the organiza-

NATO Research and Technology Organization

The Research and Technology Organization (RTO) was formed in 1998 by the merger of two NATO bodies: the Advisory Group for Aerospace Research and Development (AGARD) and the Defense Research Group (DRG). The aim of the merger was primarily to ensure that NATO's structure was better adapted to the changing defense environment, in particular by providing a common focus for all NATO research and technology activities and developing a research and technology strategy for NATO. The RTO has carried out both tasks in the short time that has elapsed since its formation, and has just started to implement the strategy.The RTO comprises the Research and Technology Board (RTB) and its subordinate bodies and the Research and Technology Agency.

The Research and Technology Agency is tasked withy providing support to the RTB and with executing those actions required to support the development, coordinatinon, and execution of the RTO scientific and technical program. RTA staff include about thirty NATO civil servants and a further twenty staff members, both military and civilian, supplied voluntarily by the nations for limited periods. Its headquarters and most of the staff are in France, but a small unit is located in NATO headquarters in Brussels, Belgium.

The Research and Technology Board is the highest authority within the RTO and serves as the single integrating body within NATO for the direction and coordination of defense research and technology and is the policy body. The RTB is tasked by the North Atlantic Council through both the Military Committee (MC) and the Conference of National Armaments Directors (CNAD). Its membership comprises up to three leaders in the field of defense research and technology from each NATO nation capable of speaking with authority on science and technology and their application to military problems. These members may come from government, industry, or academia. Ex officio representatives also are appointed by the NATO research and technology agencies NATO Consultation, Command and Control Agency (NC3A) and the SACLANT Undersea Research Center (SACLANTCEN) and the NATO Strategic Commands. The Chairman is a senior member of the Board, elected by the national members for a three-year term. Each nation appoints a national coordinator to oversee its RTO activities.

The RTB oversees the activities of all subordinate bodies and delegates the responsibility for conducting the technical program to six Technical Panels. The technical Panels and the Modeling and Simulation Group each consist of national experts, including a number of members at large, who are internationally recognized experts from the NATO nations. The Panels are the heart of RTO, because they propose, develop, and steer the various tasks that together make up the technical program of the organization. The missions of the six Panels are:

- **Applied Vehicle Technology (AVT)**: to improve the performance, affordability and safety of vehicle platforms, propulsion, and power systems through the advancement of appropriate technologies. The AVT Panel addresses technology issues related to vehicle platforms, propulsion,, and power systems operating in all environments including land, sea, air, and space, for both new and aging systems.

- **Human Factors and Medicine (HFM):** to optimize performance, health, well-being, and safety of the human in operational environments with consideration of affordability. This involves understanding and ensuring the physical, physiological, psychological and cognitive compatibility among military personnel, technological sytems, missions, and environments. The HFM Panel covers the fields of human factors, operational medicine, and human protection in adverse environments.

- **Information Systems Technology (IST):** to identify and review areas of research of common interest, to recommend the establishment of activities in these areas and to initiate and approve exploratory teams. The IST Panel covers the fields of information warfare and assurance, information and knowledge management, communica tions and networks, and architecture and enabling technologies

- **Studies, Analysisj and Simulation (SAS):** to conduct studies and analyses of an operational and technology nature, exchange information on operational (OA) analysis technology, advance the development of OA methods and tools, and provide a forum for NATO modeling and simulation oriented toward operational issues.

- **Systems Concepts and Integration (SCI):** to advance knowledge concerning advanced systems, concepts, integration, engineering techniques, and technologies across the spectrum of platforms and operating environments to ensure cost-effective mission area capabilities, including integrated manned and unmanned air, land, sea, and space defense systems and the associated weapon and countermeasure integration. Panel activities focus on NATO and national mid- to long-term, system-level operational needs.

- **Sensors and Electronics Technology (SET):** to advance technology in electronics and passive/active sensors as they pertain to reconnaissance, surveillance, and target acquisition, electronic warfare, communications, and navigation, and to enhance sensor capabilities through multi-sensor integration/fusion. This concerns the phenomenology related to target signature, propagation, and battlespace environment, EO, RF, acoustic and magnetic sensors, antenna, signal and image processing, components, sensor hardening, and electromagnetic compatibility.

Source: NATO RTO mission statements available at http://www.rta.nato.int/

tion because they formulate, execute, and report on more than 100 technical activities that take place annually involving several thousand scientists and engineers.[7] It may be appropriate for the United States to set as a goal chairing three panels at any one time, as well as making individuals available to serve as vice chairs of others. Furthermore, the individuals made available to serve in these positions should be high-ranking leaders (preferably members of the Senior Executive Service) who direct significant resources within the U.S. defense laboratory structure.

The United States also must take a much more active role in sharing basic and applied research with NATO partners. The United States participates in most RTO activities, but not at a level consistent with its very large investment in defense research and technology and not across the full spectrum of RTO activities. Whereas, for example, participation in air platform related technologies might sometimes be sufficient, the same cannot be said of naval-related or space-related technologies. Failure by the United States to address these leadership and participation areas is every bit as significant as the funding-related deficiencies of other NATO members.

If the United States moves to share more of its basic and applied research information, however, the other NATO nations must be receptive, particularly where doing so can be done with modest infrastructure investments. Failure to be receptive may well eliminate these nations from access to, or use of, such technology in the future, simply because it is so unknown to them. Also, issues of future equipment procurement must not get in the way of research. It is incumbent on the total NATO research community to consider, whenever possible, technical approaches that will not result in a single strategy for future equipment purchases.

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Technology Areas

There are many areas of technology that especially lend themselves to a more aggressive posture by the NATO RTO on sharing. Although it is impossible to mention all of these, at least three must get special mention: distributed mission training, sensor fusion, and information technology. It is also important to note that the NATO Response Force (NRF) will be especially dependent on these technologies; consequently, they must receive priority consideration for funding.

Distributed mission training will be absolutely essential for the NRF. The ability to link simulators, actual equipment, and personnel from various geographic locations on both sides of the Atlantic has been demonstrated to some extent by technologists and operational forces. As elements of the NRF, with all of their different equipment, are moved into and out of readiness, there is simply no other way to keep them fully prepared to execute their missions. The United States and the United Kingdom have made significant progress in this area, especially with their air forces. Equal progress across broader technology areas and across many more nations is essential.

Sensors have become the enabler in the Information Age, and the near-real-time fusion of information from a vast array of many different types of devices is key to NATO military capability. These devices include the full range of sensors on air-, space-, land-, and sea-based platforms that cover the complete electromagnetic spectrum. This is an area that lends itself to participation by a wide variety of large and small nations. Larger nations with larger budgets will no doubt pursue a broader range of sensor options, but smaller nations with more limited budgets can certainly do research in some of the vital areas and, by partnering with other nations, can pursue significant activities in sensor fusion. This area also lends itself to research at the component level or with almost any combination of components and platforms. There also is significant work that can be performed in sensor fusion algorithms as well as automatic target-recognition algorithms. Again, because of this diversity, large or small nations can become involved to whatever level they can afford.

Information technology is, of course, the glue that holds today's modern societies together. There are so many elements of this technology area that it is almost impossible to imagine how any nation could not find a niche area. One of the more appealing areas for some may be fundamental mathematics. This is an area that requires a modest infrastructure investment to enter and that lends itself to partnering as a nation moves toward more applied activities, such as with sensors and sensor fusion. The interaction of machine-based information technology with human elements is another niche of this research area that enables numerous contributions at various levels of investment and with various levels of infrastructure. The overall area of information technology is one in which European members of NATO, particularly the United Kingdom and France, have invested broadly, and one that is perhaps most promising in terms of closing or preventing a technology gap.[8]

The RTO also should seek more involvement with, and participation by defense industries from both sides of the Atlantic. A case could perhaps be made that contributions by European defense industries contribute significantly to the better balancing of vast disparities in military research and technology funding. Also, the technical areas mentioned above could especially lend themselves to increased industry involvement. To this end, the RTO should request the NATO Industrial Advisory Group to investigate this matter, with specific emphasis on the magnitude and technical excellence of non-government-sponsored, defense-relevant, industrial research.

Infrastructure and Workforce

Just as the military dimension of NATO is working to modernize and transform itself into an agile force, the technical dimension must do the same. This is particularly true with respect to physical infrastructure and manpower. The cost associated with maintaining infrastructure for technologies that are not part of the modern equation must be eliminated. Just as we no longer need large, immobile land armies in NATO, neither do we need antiquated laboratories

and facilities that are not highly relevant to the challenges of current and future technologies.

Similarly, the workforce in defense research and technology needs to be one that is skilled in science, mathematics, and engineering for the future, not the past. The workforce of the future, from both national and NATO perspectives, would also benefit significantly from more prolonged exposure to each other. There is no better way to share technology than to share the people who are experts in it. To this end, one-, two-, and three-year laboratory exchange programs, both to learn and to teach, should be pursued much more vigorously than is currently done. The United States is especially deficient in this area.

Allied Command Transformation

The formation in 2003 of the NATO Allied Command Transformation created a golden opportunity for sharing technology and demonstrating it in multinational forums. ACT must seize this opportunity and, working with the RTO, Main Armament Groups, and member nations, among others, provide the framework and leadership to demonstrate emerging technologies across the broadest possible spectrum of NATO nations.[9] This is not a trivial task. Individual nations repeatedly struggle with transitioning technology from the laboratory to the military user. ACT should, and must, assume this role for NATO as a whole. The recent creation of a NATO Technical Advisory Board, with the RTA Director and Deputy Director as members, will help facilitate this process, as will emphasis on joint experimentation, exercises, and assessment. It also is important to note that both activities are led by NATO flag officers. One particularly difficult area, once again, will be funding. To this end, ACT must work carefully with NATO as an entity and with individual nations (which fund the military research and development) to obtain sufficient funding commitments from all to demonstrate the emerging technologies and to enhance their availability for transition. A key element of this is for nations to accept the responsibility for funding demonstrations of their technologies in a NATO environment.

Conclusion

As perplexing as today's NATO capabilities gap may be, some relatively simple and straightforward actions could prevent a potential divergence driven by technology. Foremost among these actions is increased investment in defense research and technology by the European members. The good news here is that, with only slight modifications (not additions) to current total defense expenditures, and using funds that will be available as they restructure their forces, these nations could not only double their current investment but take significant strides to ensure that they are not left behind in a world dominated by technology.

The second important action is an American initiative. The United States simply must make sharing more of its fundamental basic and applied research with NATO partners a higher priority. This requires at least two subset actions: increased leadership in the Research and Technology Organization, especially at the panel level, and a far greater level of participation across all technical areas in the RTO. These two primary actions, coupled with other actions by all NATO nations and the Allied Command Transformation proposed above, offer the potential to dramatically improve a situation that much needs immediate attention. NATO has both a capabilities gap and a technology gap. A commitment by every NATO nation to invest 3 percent of its military budget in research and technology, would go far toward reducing both gaps and keeping NATO militarily relevant to the new strategic environment.

Notes

1. The U.S. defense budget for fiscal year 2004 is approximately $400 billion. Of the NATO nations, The United Kingdom has the next largest defense budget at approximately $40 billion, with France second at approximately $30 billion and Germany third at approximately $25 billion.

2. Equipment expenditures include research and development.

3. The figures given here are taken from the NATOweb site on "Financial and Economic Data Relating to NATO Defence—Defence Expenditures of NATO countries (1980-2003)," accedssed at www.nato.int/docu/pr/pr2003.htm#december.

4. The F-35 will also most likely be acquired by other NATO nations, including the UK.

5. The NATO Research and Technology Organization is described in detail in "NATO Defense Science and Technology," *Defense Horizons 24* (Washington, DC: National Defense University Press, March 2003.

6. Technical activities include task groups, symposia, workshops, lecture series, cooperative demonstrations of technology, and other activities.

7. For an excellent discussion on C4ISR technology in Europe, see the recent work of Gordon Adams at The Elliott School of International Affairs, George Washington University.

8. The main armament groups are the NATO Army Armaments Group, the NATO Navy Armaments Group, and the NATO Air Force Armaments Group. They are primarily concerned with development and procurement of equipment.

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